

# PATENT SPECIFICATION

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## (54) ROTARY COUPLINGS FOR USE IN TORQUEMETERS

(71) We, LUCAS INDUSTRIES LIMITED, formerly known as Joseph Lucas (Industries) Limited, a British Company, of Great King Street, Birmingham B19 2XF, do hereby declare the invention, for which we pray that a Patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to rotary couplings for use particularly, but not exclusively, in torquemeters and has for its object to provide a rotary coupling which can be sensitive to changes in torque in the lower torque ranges and which can be used over a wide range of torques.

According to the present invention, there is provided a rotary coupling comprising a rotary driving member, a rotary driven member, and resilient, rotary drive means connecting the two members, the resilient, rotary drive means including a plurality of stops rotatable with one of the member and a plurality of resilient elements rotatable with the other member and arranged to engage respective stops during rotation of the coupling, the arrangement being such that, at rest, with one or more of the resilient elements engaging its stop or their respective stops, at least one other resilient element is spaced from its respective stop so that, in use, when an increasing torque is applied through the coupling, the drive is taken first through said one or more resilient elements and then also through said at least one other resilient element as the said one or more resilient elements deflect under the increasing applied torque.

Preferably, the arrangement is such that, at rest, with one resilient element in contact with its respective stop, the other resilient elements are spaced at varying distances from their respective stops.

The elements may have the same degrees of resilience or may be graded in their degrees of resilience so that the said one resilient element is the most resilient and the element which is furthest from its respective

stop, with the coupling at rest, is the least resilient.

The resilient elements may be in the form of strips which extend radially or parallel with respect to the axis of rotation of the member to which they are attached. The member carrying the resilient elements is preferably the driving member.

The coupling may be used in a bi-directional transmission, in which case, there are provided a pair of the stops for each resilient element, the stops of each pair being spaced apart on opposite sides of the respective resilient element relative to the direction of movement of said element.

Embodiments of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:—

Figure 1 is a side elevation of a torque-meter incorporating a rotary coupling according to the present invention,

Figure 2 is a section on the line A—A of the torquemeter of Figure 1,

Figure 3 is an elevation of another form of torquemeter incorporating a rotary coupling also according to the invention,

Figure 4 is a section on line B—B of the torquemeter of Figure 3,

Figure 5 is a section, similar to Figure 4, of part of another form of rotary coupling according to the present invention,

Figure 6 is a longitudinal sectional view of a further torquemeter incorporating a rotary coupling according to the present invention, and

Figure 7 is a view of part of the torque-meter of Figure 6.

Referring to Figures 1 and 3 of the drawings, the torquemeter comprises a driving shaft 10 upon which is mounted a cylindrical driving member 11 supporting a boss 12 having integrally attached thereto three resilient strips 13, 14 and 15. The resilient strips 13, 14, and 15 are equi-angularly disposed around the boss 12 and extend radially with respect to the axis of rotation of the cylindrical driving member

11. The resilient strip 13 is thinner than the resilient strip 14 which, in turn, is thinner than the resilient strip 15 so that the resilience of the strips 13, 14 and 15 decreases from strip 13 to strip 15. Associated with resilient strips 13, 14 and 15 are stops 16, 17 and 18 which are mounted on a cylindrical driven member 19 carried on a driven shaft 20. The resilient strips 13, 14 and 15 together with the stops 16, 17 and 18 form a resilient drive between the cylindrical driving member 11 and the cylindrical driven member 19. The arrangement of the resilient drive is such that, when the torquemeter is at rest with the resilient strip 13 engaging the stop 16, the resilient strips 14 and 15 are spaced from their respective stops 17 and 18, the spacing between the strip 14 and its respective stop 17 being greater than the spacing between the resilient strip 15 and its respective stop 18.

Vernier scales 21 and 22 are marked on the outer peripheral surfaces of the cylindrical driving member 11 and cylindrical driven member 19.

In use, rotation of the driving shaft 10 and member 11 causes rotation of member 19 through the intermediary of the resilient drive. Initially, the drive between the member 11 and member 19 is effected solely through the intermediary of resilient strip 13 and stop 16. However, when the torque transmitted by the coupling increases beyond a predetermined value, the relatively resilient strip 13 has deflected sufficiently for the less resilient strip 14 to contact its respective stop 17 so that the drive is transmitted through both strips 13 and 14 and their respective stops 16 and 17. When the torque applied through the rotary coupling has increased to a further predetermined value, the resilient strip 14 has deflected sufficiently for the resilient strip 15 to contact its respective stop 18 so that drive is transmitted through all the strips 13, 14 and 15 and their respective stops 16, 17 and 18.

Thus, the relative displacement between member 11 and 19, caused by deflection of one or more of the strips 13, 14 and 15, gives an indication of the torque applied through the rotary coupling. By appropriately calibrating the vernier scales 21 and 22 and viewing these in the light of a stroboscope (not shown) triggered from a slip ring (not shown) on the driving shaft 10 and a mechanical contact strip (also not shown), a reading of the torque applied through the rotary coupling can be obtained.

It is to be appreciated that, in the lower torque ranges, a relatively large displacement between members 11 and 19 can be obtained due to the fact that the most resilient strip 13 is the only one which trans-

mits the drive. Thus, the coupling is very sensitive to small changes in torque in the lower torque range. Additionally, the provision of the further strips 14 and 15 and respective stops 17 and 18 enables a very wide range of torques to be measured without effecting the sensitivity in the lower torque ranges.

Referring to Figures 3 and 4 of the drawings, the torquemeter comprises a driving shaft 110 upon which is mounted a cylindrical driving member 111 carrying adjacent its periphery a series of four equi-angularly spaced resilient strips 113, 114, 115 and 123 which extend parallel to the axis of rotation of the member 111. The resilient strips 113, 114, 115 and 123 are associated with stops 116, 117, 118 and 124, respectively, mounted on a cylindrical driven member 119 carried on a driven shaft 120. The resilient strips 113, 114, 115 and 123 together with their respective stops 116, 117, 118, 124 constitute a resilient drive between members 111 and 119.

Vernier scales 121 and 122 are marked on the peripheral surfaces of member 111 and 119, respectively.

As opposed to the resilient strips 13, 14 and 15 of the embodiment of Figures 1 and 2, the strips 113, 114, 115 and 123 are all of the same thickness and have the same degree of resilience. The arrangement of the strips 113, 114, 115 and 123 relative to the stops 116, 117, 118 and 124, respectively, is such that, when the coupling is at rest and the strip 113 abuts against stop 116, the other strips 114, 115 and 123 are spaced from their respective stops 117, 118, and 124, the spacing between strip 114 and its respective stop 117 being less than the spacing between the strip 115 and its respective stop 118, which, in turn, is less than the spacing between the strip 123 and its respective stop 124.

The rotary coupling illustrated in Figure 3 and 4 operates in the same manner as the rotary coupling of Figures 1 and 2. However, the resilient strips in the rotary coupling of Figures 3 and 4 are less likely to be deformed due to centrifugal forces arising during high speed rotation of the coupling than the resilient strips of the rotary coupling of Figures 1 and 2.

Referring now to Figure 5, the rotary coupling illustrated therein is similar to that of Figure 4 in that resilient strips 213, 214 and 215 thereof extend parallel to the axis of rotation of a rotary drive member (not shown), similar to member 111, carrying the strips 213 to 215. In this embodiment, however, pairs of stops 216a, 216b, 217a, 217b, and 218a, 218b are associated with the respective strips 213, 214 and 215. The stops of each pair are spaced apart on opposite sides of the respective strip relative to the

direction of movement of the latter. The stops 216a to 218b are carried on a driven member 219 similar to member 119. The spacing between the stops of each pair increases from stops 216a and 216b to 218a and 218b. The flexibility of the strips decreases from strip 213 to strip 215.

In this embodiment, the rotary coupling is effective in either direction of rotation and can thus be used in a bi-directional transmission. In such a case, vernier scales similar to scales 21, 22 and 121, 122 need not be provided.

Referring now to Figures 6 and 7, the torque-meter illustrated therein comprises a rotary driving member 311 including a rotary support plate 312 mounting cylindrical sleeve 313. The cylindrical sleeve 313 has an integral enlargement 314 at its end adjacent plate 312. The enlargement 314 has a series of three equi-angularly spaced recesses 315 therein. Three resilient strips 316 (only two shown — see Figure 6) are secured by bolts 317 in the respective recesses 315 to extend parallel to the axis of rotation of driving member 311 towards a driven member 318. The driven member 318 is provided with a series of bores 319 therein (only two shown) which receive three stops (not shown) similar to the stops 116, 117 and 118 of the embodiment illustrated in Figures 3 and 4. Each stop is associated with one of the strips 316 as described in the previous embodiments.

The driven member 318 has an integral hollow spigot 320 which extends in an axial direction into sleeve 313 and is supported by bearings 321 so that relative angular movement between members 311 and 318 can occur. The torque-meter operates in a similar manner to that described with reference to Figures 3 and 4. If desired, 6 stops may be provided instead of three stops so that the device may operate bi-directionally.

#### WHAT WE CLAIM IS:—

1. A rotary coupling comprising a rotary driving member, a rotary driven member, and resilient, rotary drive means connecting the two members, the resilient, rotary drive means including a plurality of stops rotatable with one of the members and a plurality of resilient elements rotatable with the other member and arranged to engage respective stops during rotation of the coupling, the arrangement being such that, at rest, with one or more of the resilient elements engaging its stop or their respective stops, at least one other resilient element is spaced from its respective stop so

that, in use, when an increasing torque is applied through the coupling, the drive is taken first through said one or more resilient elements and then also through said at least one other resilient element as the said one or more resilient elements deflect under the increasing applied torque.

2. A rotary coupling as claimed in Claim 1, wherein the arrangement is such that, at rest, with one resilient element in contact with its respective stop, the other resilient elements are spaced at varying distances from their respective stops.

3. A rotary coupling as claimed in Claim 1 or 2, wherein the elements have the same degree of resilience.

4. A rotary coupling as claimed in Claim 2, wherein the elements are graded in their degrees of resilience so that the said one resilient element is the most resilient and the element which is furthest from its respective stop, with the coupling at rest, is the least resilient.

5. A rotary coupling as claimed in any preceding Claim, wherein the resilient elements are in the form of strips which extend radially with respect to the axis of rotation of the member to which they are attached.

6. A rotary coupling as claimed in any one of Claims 1 to 4, wherein the resilient elements are in the form of strips which extend parallel to the axis of rotation of the member to which they are attached.

7. A rotary coupling as claimed in any preceding Claim, wherein the member with which the elements are rotatable is the driving member.

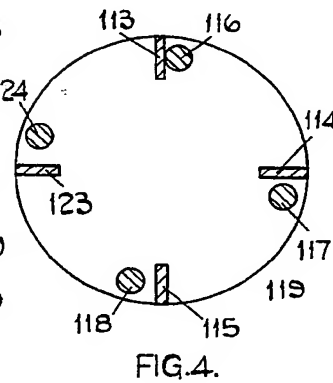
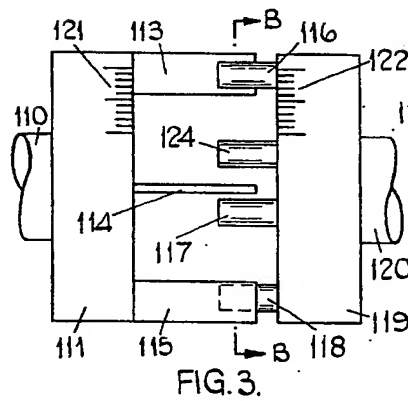
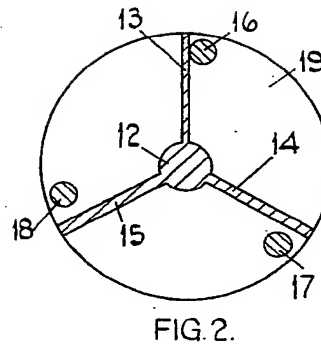
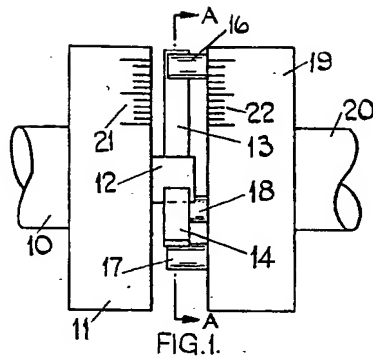
8. A rotary coupling as claimed in any preceding Claim wherein a pair of the stops are provided for each resilient element, the stops of each pair being spaced apart on opposite sides of the respective element relative to the direction of movement of said element.

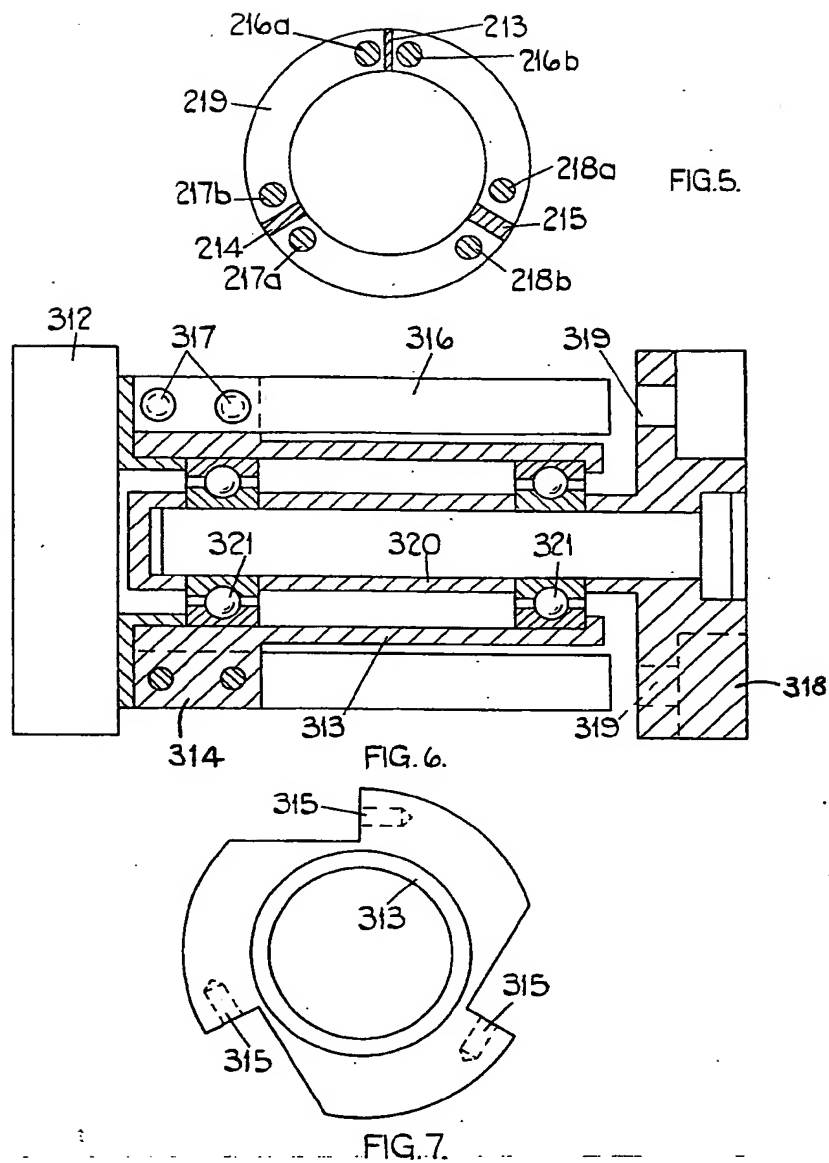
9. A rotary coupling as claimed in any preceding claim, further including means for indicating relative displacement between the two members under applied torque.

10. A rotary coupling substantially as hereinbefore described with reference to Figs. 1 and 2, or Figs. 3 and 4, or Fig. 5 or Figs. 6 and 7 of the accompanying drawings.

11. A torque-meter including a rotary coupling as claimed in Claim 9 or 10.

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